

# Natural Gas Research Initiatives for FY 2014/15



**Presented at the Stakeholders Workshop  
California Energy Commission  
January 28, 2014  
1:30 pm - 5:00 pm**

# Agenda

Time	Topic
1:30	Introduction and Purpose – Laurie ten Hope
2:00	Staff Presentations on Proposed Natural Gas Research Initiatives <ul style="list-style-type: none"><li>• Energy Efficiency – Virginia Lew, Bradley Meister, Michael Lozano</li><li>• Renewable Energy and Advanced Generation – Aleecia Gutierrez, Rizaldo Aldas</li><li>• Energy Infrastructure – Fernando Piña, Johann Karkheck, Guido Franco, Reynaldo Gonzalez</li></ul>
4:00	Public Comments
4:45	Closing/Next Steps – Laurie ten Hope

# Introduction

- For the natural gas 2013-14 budget, the Energy Commission R&D Program included a public vetting process with Stakeholders that included a public workshop
- For the upcoming natural gas 2014-15 budget, the Energy Commission R&D Program released a questionnaire to researchers to seek ideas for natural gas research initiatives
  - Received 71 proposed initiatives
  - Program staff are evaluating each initiative for consideration for inclusion in 2014-15 budget

# General Approach

- Identify research gaps to develop research initiatives:
  - Discussion with utilities, governmental agencies and stakeholders
  - Road maps
  - Public meetings with industry and trade associations
  - Research ideas submitted by the public
- Research projects selected through competitive solicitations
- Increase program efficiency by collaborating with internal and external stakeholders (e.g., other Energy Commission research areas, state and federal agencies, utilities)
- Policy connections linked to energy issues
- Clearly identify benefits

# **Role of Stakeholders**

## **■ Role of Stakeholders**

- Advice and comments on the initiatives
- Alerting Energy Commission staff to possible duplication of efforts
- Advising Energy Commission staff on opportunities to gain synergies in research efforts
- Facilitating the effective transfer and use of research results

# Budget and Priorities

- Transparent budget process
- Priorities
  - Loading Order
  - Ratepayer benefits and California focus
  - Emphasis shift to development and demonstration
  - Enhanced outreach strategy
- Strategic Natural Gas budget look ahead
- Support State Energy Policies and Governor's priorities
- Requested Stakeholders ideas on research initiatives

# Natural Gas Research Areas/Initiatives

- **Energy Efficiency**
  - Buildings Energy End-Use Efficiency
  - Industrial, Agricultural and Water Efficiency
- **Renewable Energy and Advanced Generation**
  - Combined Heat and Power (CHP)
- **Energy Infrastructure**
  - Natural Gas Pipeline Integrity
  - Energy-Related Environmental Research
  - Natural Gas-Related Transportation

# Prior Fiscal Year and Proposed - Natural Gas 2014/2015 Budget

Areas	Approved FY 2013/14 Natural Gas Budget	Proposed FY 2014/15 Natural Gas Budget
<b>Energy Efficiency</b>	\$8,541,000	\$8,600,000
Buildings End-Use Energy Efficiency	\$4,200,000	\$4,300,000
Industrial, Agriculture and Water Efficiency	\$4,341,000	\$4,300,000
<b>Renewable Energy and Advanced Generation</b>	\$3,500,000	\$3,500,000
<b>Energy Infrastructure</b>	\$9,500,000	\$9,500,000
Natural Gas Pipeline Integrity	\$2,500,000	\$2,500,000
Energy-Related Environmental Research	\$3,000,000	\$3,000,000
Natural Gas-Related Transportation	\$4,000,000	\$4,000,000
<b>Technical Support</b>	\$100,000	\$140,000
<b>Program Administration Labor</b>	\$2,359,000	\$2,260,000
<b>Total</b>	\$24,000,000	\$24,000,000

# Benefits Estimation of Natural Gas Research Projects

- Implementing a comprehensive benefits methodology
- Preliminary estimates of potential savings from 17 natural gas research projects\*
  - \$253 million/year in ongoing cost savings for ratepayers
  - 2.3 million metric tons/year of GHG reduction
  - Follow-up on selected commercialized products and estimated job creation

\*California Energy Commission, 2013 Natural Gas Annual Report to the California Public Utilities Commission, October 2013

# Workshop Format

- Each Natural Gas R&D team will discuss their presentation
- Questions related to the research initiatives will be posed to the Stakeholders at the end of each research area
- To ensure each team has time to complete their presentations, some questions may need to be deferred to the public comment period
- There will be a public comment period at the conclusion of the presentations

# Natural Gas Research Areas/Initiatives

## Energy Efficiency

- Buildings End-Use Energy Efficiency
- Industrial, Agricultural and Water Efficiency

# Buildings End-Use Energy Efficiency



**Presenter:**  
**Bradley Meister, P.E.**

# Goals

Conduct RD&D to reduce natural gas use in buildings and communities while addressing indoor environmental quality:

- Advance energy efficient technologies, design tools, and operations
- Develop and demonstrate affordable, comfortable, energy-efficient buildings and technologies for direct applications into the marketplace and to inform codes and standards
- Maintain or increase productivity while reducing energy consumption and ambient or indoor emissions
- Improve information resources for sharing research results

# Policy Drivers

## Governor's Clean Energy Jobs Plan (2010)

- Adopt timeline to achieve Zero Net Energy (ZNE) in homes and commercial buildings in building standards
- Make existing buildings more efficient
- Adopt stronger appliance efficiency standards



## Integrated Energy Policy Reports/Energy Action Plan

- Target research in energy efficient technologies, techniques, building operations/commissioning for newly constructed and existing buildings
- Research to support new/updated building and appliance efficiency standards
- Support pilot programs/demonstrations of ZNE buildings
- Collaborate with utilities to improve energy efficiency programs

## California Public Utilities Commission- Energy Efficiency Strategic Plan (2008/2011)

- All new residential construction in California will be ZNE by 2020.
- All new commercial construction in California will be ZNE and 50% of existing buildings will be equivalent to ZNE by 2030
- 40% reduction in energy consumption for existing homes (2008 baseline) by 2020
- HVAC industry and market to be transformed to ensure that energy performance is optimal for California's climate

## SB 1250 (Perata and Levine, Chapter 512, Statutes of 2006)

- Undertake public RD&D projects that are not adequately provided for by competitive and regulated energy markets and that advance energy science or technologies of value to California citizens

# Policy Drivers

## **AB 32 (Núñez, Chapter 488, Statutes of 2006)**

- Reduce GHG emissions in CA to 1990 levels by 2020 – Scoping Plan emphasizes energy efficiency to slow the rate of GHG emissions

## **AB 758 (Skinner, Chapter 470, Statutes of 2009)**

- Achieve greater energy savings in the state's existing buildings

## **AB 549 (Longville, Chapter 905, Statutes of 2001)**

- Improve energy efficiency of existing buildings

## **AB 1103 (Saldaña, Chapter 533, Statutes of 2007) and**

## **AB 531 (Saldaña, Chapter 323, Statutes of 2009)**

- Benchmark existing building energy use and provide public disclosure

## **California's Clean Energy Future Initiative**

- Advance carbon-cutting energy efficiency innovation

## **Public Utilities Code Section 25402.8**

- Consider impacts to indoor air pollution when assessing new building standards relating to conservation of energy

# Major Accomplishments

## Residential Hot Water Program

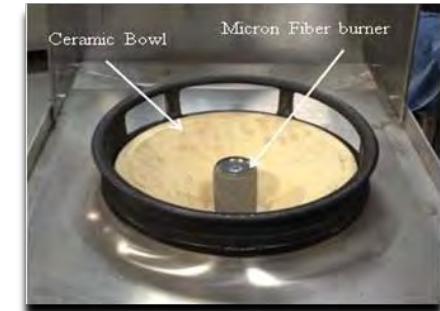
- **Contractor:** Gas Technology Institute
- **PIER amount:** \$1,984,761 (Match \$406,766)
- **Description:** Approximately 49% of statewide residential natural gas use is for water heating. This research aimed to reduce natural gas consumption for residential water heating through several closely linked project activities. The following are the results:
  - Integrated hot water generation and distribution system analysis tool
  - Developed efficient water heating equipment and piping system best practices, and design guide
  - Developed laboratory evaluations of water heating equipment and hot water distribution piping
  - Performed field monitoring of water heaters and consumer behavior surveys
  - Provided training on advanced water heating system to plumbing trades and others
- **Rate payer benefits:** Potential to reduce statewide natural gas consumption for residential water heating by 3-4% (equivalent to approximately 86 million therms and 503,000 metric tons GHG).
- **Next steps:** Research is complete, final report published on the CEC website; working with SoCalGas at Energy Resource Center and others to get information into the marketplace.



# Major Accomplishments

## Improve the Energy Efficiency of Commercial Cooking Equipment

- **Contractor:** Gas Technology Institute
- **PIER funding amount:** \$1,985,502 (\$917,875 match)
- **Description:** Field tested and improved selected food service equipment to document and verify energy savings.
- **Results:** Comprehensive test plans were developed and equipment modifications were field tested to verify the installed efficiency of a variety of commercial cooking equipment by the following amounts: Open top range (15%), conveyor oven (12%), convection oven (14%), wok (20%), under-fire broilers (17%), over-fire broilers (17%) and water heater system performance (15%).
- **Ratepayer benefits:** Projected savings of 29.7 million therms/year and 173,800 metric tons of GHG reduction, assuming 1% reduction in current gas usage in commercial cooking.
- **Next steps:** Research is complete; final report published on CEC website. Contractor continues to work with manufacturers to finalize and optimize new equipment to needs of restaurant owners; SoCalGas and others working to demonstrate new equipment with customers and get information into the marketplace.



# Major Accomplishments

## Mini-Channel Technology to Improve Solar Water Heaters

- **Contractor:** University of California, Merced
- **PIER funding amount:** \$333,202 (plus \$10,560 in-kind)
- **Description:** Design, manufacture, test and demonstrate the cost effectiveness of a solar water heater using mini-channel technology as the solar collector.
- **Preliminary Results:** Successfully designed and constructed a lower cost solar thermal collector that uses aluminum mini-channel technology as an alternative to using expensive copper tubing. The technology increases thermal efficiency of solar collectors by 10% over copper tube collectors. Estimated system cost is \$577 to \$968 per collector or \$14/ft<sup>2</sup> to \$24 /ft<sup>2</sup> which is ≈ 33% lower than conventional solar systems.
- **Ratepayer benefits:** Projected energy savings of 120 therms/year per system and 0.67 MT/year per system of GHG reduction compared to conventional natural gas water heaters. Reduction in solar water heater cost could make these systems more affordable and result in increased market penetration.
- **Next steps:** Working with water heater manufacturers to commercialize the aluminum mini-channel technology; developing a copper mini-channel technology for high temperature and high pressure industrial applications.



# Major Accomplishments

## Healthy Homes – Exposure to Unvented Combustion Gases

- **Contractor:** Lawrence Berkeley National Laboratory
- **PIER funding amount:** \$1,000,000
- **Description:** Measured indoor air pollutants and assessed air quality impacts resulting from natural gas appliance use in 355 homes and as needed, identified key risk factors and controls for safe use.
- **Research results:** Homes using gas cooking burners had higher nitrogen dioxide ( $\text{NO}_2$ ), nitrogen oxides ( $\text{NO}_x$ ) and carbon monoxide (CO) than homes with electric cooking. Levels increase with more cooking activity and with gas pilots. CO and  $\text{NO}_2$  levels exceeded California outdoor standards in about 5% and 25% of sampled homes, respectively. Other gas appliances were not associated with elevated pollutant levels.
- **Rate payer benefits:** Understanding the key risk factors enables controls to reduce health risks for California natural gas users.
- **Next steps:** Develop test methods to quantify effectiveness of range hood use to reduce acute exposure to  $\text{NO}_2$ ,  $\text{NO}_x$ , CO, and particulate matter (PM2.5) associated with gas burners and cooking.



Kitchen



Bedroom



Water Heater

# Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<b>Research for Commercial Facilities</b>	Improve efficiency of food service appliances	<ul style="list-style-type: none"> <li>• Field tested and confirmed the improved efficiency of convection ovens, woks, range tops, broilers and conveyor ovens.</li> <li>• Project complete and report published. Report recommends future research: improvements to advanced under-fired broiler, and development of high-efficiency, “powered-burner” for commercial gas range tops and other commercial appliances.</li> </ul>
<b>Research for Residential and Commercial Facilities</b>	Improve hot water generation and distribution systems	<ul style="list-style-type: none"> <li>• Residential Hot Water Program completed and final report published</li> <li>• New research project initiated on hot water distribution to reduce cross over and improve balancing in multifamily buildings and multifamily/low income demonstration. Results anticipated in 2015.</li> </ul>
<b>Research for Residential and Commercial Facilities</b>	Advanced energy efficient heating systems and building envelopes	<ul style="list-style-type: none"> <li>• Research continues on innovative envelope sealing methods, new technology for ground source heat pumps, and phase change materials (PCM) for hydronic heating. Projects to be completed December, 2014.</li> <li>• New research project initiated to research and evaluate : a) use of PCM that can be embedded in cement walls, and b) improve envelope measures for manufactured housing. Project results anticipated in 2015.</li> </ul>
<b>Research for Residential and Commercial Facilities</b>	Cross-Cutting-ZNE and Low Income Housing	New research projects initiated to demonstrate : a) integrated energy efficiency retrofits for low income multifamily housing and commercial building renovation to achieve cost effective ZNE; and b) solar thermal heat pumps.

# Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<b>Reduce Environmental Footprint</b>	Improve indoor environmental quality	<ul style="list-style-type: none"><li>Identified key factors for range hoods (i.e. design, shape, air flow) to control in-home exposures to NG cooking pollutants</li><li>Roadmap is in final review</li></ul>
<b>Building Natural Gas Technology Grant Program</b>	Competitive grant solicitation that target improvements to processes and operations that reduce natural gas use, improve indoor environmental quality in buildings, and reduce emissions of oxides of nitrogen (NOx) associated with using natural gas-burning systems	<ul style="list-style-type: none"><li>Solicitation released and is in process</li><li>Proposals due February 4, 2014</li><li>Up to \$6 M</li><li>Awards Fall 2014</li><li><a href="http://www.energy.ca.gov/contracts/PON-13-503/">www.energy.ca.gov/contracts/PON-13-503/</a></li></ul>
<b>Research Roadmap for Building Energy Efficiency</b>	Stakeholder driven process to develop a roadmap to identify priority building energy efficiency research initiatives that will reduce natural gas consumption and improve air emissions in a cost-effective manner with the greatest beneficial impacts to natural gas ratepayers.	<ul style="list-style-type: none"><li>Stakeholder comments received through public workshops</li><li>Draft anticipated early 2014 for public comment</li></ul>

# Proposed Funding Initiatives for FY 14/15

**Buildings End Use Energy Efficiency Initiatives-** Develop, demonstrate advanced and new technologies, tools and strategies to reduce natural gas use and cost that also lead to improvements in environmental quality. Current research initiatives based on results from past activities, examples:

- **Water Heating and Distribution**: Past research focused on integrated models, heat transfer analysis of smaller pipes, some analysis of distribution systems and development of best practices. There is a need to focus on lowering costs of high efficiency systems and development of new strategies for cost-effectively reducing pipe heat loss in existing homes, including under slab.
- **Food Service**: Past research resulted in improvements to six initial types of commercial cooking equipment but there is a need to reduce the cost of energy efficient equipment without compromising cooking performance and to improve equipment controls and range burners.
- **HVAC**: Previous research focused on duct sealing , diagnostic tools and controls, and improvements to building envelope and HVAC systems, such as use of phase change materials in fluids and building materials. However, the need is finding ways to reduce high efficiency equipment cost and determining cost effective approaches to address distribution issues and sealing building envelopes.
- **Cross-Cutting**: Past research included integrated demonstrations of multiple energy efficiency projects in buildings and use of renewable energy systems, such as solar thermal, to help achieve ZNE buildings. Future focus is on behavior, smart controls and combined systems that may have an overall higher efficiency.
- **Indoor Environmental Quality (IEQ)** : Previous focus was on indoor air pollutants and air quality impacts resulting from natural gas appliance usage and how to mitigate these pollutants. There is a need to continue investigating and analyzing IEQ impacts associated with energy efficiency retrofits and the optimum approaches for air cleaning or pollutant removal.

# Proposed Funding Initiatives for FY 14/15

The following are the five initiatives (numbers in red are sector specific natural gas usage):

- **Water Heating and Distribution** (49% residential and 32% commercial use):
  - Improve residential and commercial hot water distribution systems through demonstrations and development of alternatives including retrofits for existing homes.
  - Develop and demonstrate high efficiency and lower cost water heating technologies, such as natural gas heat pump technology and condensing water heaters.
  - Investigate and demonstrate potential energy savings and benefits associated with installing multiple water heating tank systems for residential and commercial buildings.
  - Improved shower heads to allow lower future flow rates (2 gpm or 1.5 gpm)
  - Develop new materials and designs to reduce cost of solar water heating systems and increase performance, such as new minichannel designs.
  - Collect and characterize energy use related to water heating and distribution across different building types (residential and commercial). Research is needed to better understand how and where energy related to hot water is used across different buildings, including data on existing water system design, pipe sizes, length of pipe, type of joints and relationship to fixtures and water consumption, and associated water waste in hot water pipes. More data will lead to better designs and options.

# Proposed Funding Initiatives for FY 14/15

- **Commercial Cooking and Food Service Equipment and Systems (23% of commercial gas use):**
  - Reduce standby energy and idle rates for burners, including use of insulation, controls, temperature setback, lids and multi-stage burners. Research to develop cost effective burner technologies that burn gas more efficiently, increase heat transferred to the food surface with enhanced temperature controls and sensing.
  - Development of high-efficiency, “powered-burner” for commercial gas range tops. Technology considerations should include pilotless ignition and optional automatic “pot sensing” controls that are cost effective and meet performance needs of the food service industry.
  - Develop high efficiency, low NOx select appliance types, such as charbroilers (including lidded), and lidded griddles that are heavily used by food service operations.
  - Develop and demonstrate integrated controls for commercial cooking equipment that would communicate with building energy management systems.
  - Develop lower-first-cost, Energy Star qualified equipment with similar cooking performance.

# Proposed Funding Initiatives for FY 14/15

- **Advanced HVAC Systems and Building Envelopes (37% residential and 36% commercial use):**
  - Develop and demonstrate more efficient air distribution designs considering ducts in the conditioned space. It is estimated that up to 30% of conditioned air leaks through ducts and building envelopes. Research is needed to quantify the potential energy and economic savings resulting from cost-effective and improved air distribution design.
  - Develop and demonstrate cost effective roof-top condensing furnaces for commercial applications. Commercial roof top condensing furnaces have the benefit of achieving AFUE's over 90%. Research is needed to lower the first-cost of, and increase market demand for condensing furnaces for commercial applications.
  - Develop and demonstrate cost effective advanced innovative building envelope materials that improve R-value of existing residential buildings.

# Proposed Funding Initiatives for FY 14/15

- **Integrated Natural Gas Systems to Achieve ZNE or High Efficiency Buildings/Systems (residential and commercial):**
  - Develop and demonstrate cost-effective integrated technologies, such as high efficiency combined space and water heating equipment or hybrid systems.
  - Develop and demonstrate next generation energy management systems (EMS) to allow for “smart” buildings, controls and metering and monitoring of natural gas usage in buildings, equipment and appliances.
    - Low cost, accurate gas meters to monitor appliance use
    - Analyze occupant behavior and motivations that could increase energy efficiency of natural gas using systems
  - Research needed to understand the interactive effects associated with gas and electric use in ZNE buildings and how to mitigate increased gas consumption caused by increased energy efficiency from electricity saving measures in heated spaces.

# Proposed Funding Initiatives for FY 14/15

- **Indoor Environmental Quality for ZNE/Low Energy Use Buildings-** About 37 percent of the natural gas used by residents and 36 percent of the natural gas used by commercial facilities is for heating. As buildings get tighter to save HVAC energy, more care is needed to ensure acceptable indoor environments.
  - Investigate and analyze the IEQ impacts of energy efficiency retrofits in buildings, including changes in ventilation systems, building shells, nearby pollutant sources, and occupant IEQ behavior, moisture risk and IAQ of buildings.
  - Assess, determine, and demonstrate the optimum approaches for air cleaning or pollutant removal to allow for the growing weatherization of buildings, especially for vulnerable populations in homes, schools, and retirement/extended care homes in high pollution areas.

# Proposed Funding Initiatives for FY 14/15

- **Potential partners:**
  - Utilities
  - Contractors
  - Manufacturers
  - Trade Organizations
  - Designers
  - Governmental agencies
  - Public/private research organizations
  - Residential and commercial customers
  - Universities
- **Outreach:**
  - Staff Technical Workshops on the Research Roadmap to Identify Future Research for Energy Efficient Natural Gas Use in Buildings
  - Discussions/meetings with utilities, governmental agencies and other stakeholders
- **Estimated rate payer benefits:**
  - Energy, water and cost savings
  - Environmental benefits (e.g., reduced GHG, improved air quality)-in general more efficiency equals less emissions
  - Potentially cost competitive advanced systems

# Proposed FY 2014/15 Budget

Initiatives	Proposed FY 2014/15 Natural Gas Budget
<p><b>Buildings End-Use Energy Efficiency</b></p> <ul style="list-style-type: none"><li>▪ Water Heating and Distribution</li><li>▪ Commercial Cooking and Food Service Equipment and Systems</li><li>▪ Advanced HVAC and Building Envelopes</li><li>▪ Integrated Natural Gas Systems to Achieve ZNE or High Efficiency Buildings/Systems</li><li>▪ Indoor Environmental Quality for ZNE/Low Energy Use Buildings</li></ul>	\$4,300,000

# Questions for the Stakeholders on Buildings End-Use Energy Efficiency Initiatives

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

# Industrial, Agricultural and Water Efficiency



**Presenter:  
Michael Lozano, P.E.**

# Goals

Conduct RD&D to help the industrial, agricultural and water (IAW) sectors:

- Increase energy efficiency
- Reduce energy use and costs
- Develop measures to meet environmental challenges while maintaining or enhancing energy efficiency
- Reduce water or other finite resources consumption or increase use of renewable energy
- Maintain or increase productivity while reducing energy consumption and emissions (e.g., low NOx)
- Commercialize technologies within 5 years of project completion with a 1% penetration/year for targeted markets
- Increase the industry's competitiveness in the global economy by reducing energy costs and GHG emissions

# Policy Drivers

## Integrated Energy Policy Report/Energy Action Plan

- Improve energy efficiency through increased R&D to reduce energy cost and GHG emissions (2007/2009)
- Conduct research to identify new technologies for achieving energy and water efficiency savings (2005)

## California Public Utilities Commission - Energy Efficiency Strategic Plan (2008/2011)

- Integrate energy efficiency with achievement of GHG goals for the industrial sector
- Increase energy efficiency and on-site renewable energy use in the agricultural sector

## AB 32 (Núñez, Chapter 488, Statutes of 2006)

- Reduce GHG emissions in CA to 1990 levels by 2020 - Scoping Plan emphasizes energy efficiency to slow the rate of GHG emissions with focus on large industrial customers

# Major Accomplishments

## Demonstrate Liquid/Supercritical CO<sub>2</sub> Industrial & Commercial Laundry Machine

- **Partners:** CO2Nexus (Prime); ARAMARK's LA laundry facility (demo site); SCE, SDG&E and LADWP (M&V)
- **PIER Funding:** \$396,200 (over \$1M in match)
- **Description:** Industrial laundry machines can annually use >300,000 gallons of water. A prototype liquid/ supercritical CO<sub>2</sub> based laundry system will reduce/eliminate water (steam/cold/hot water) consumption and eliminate need for the garment drying step.
- **Results:**
  - Tests show an energy use reduction of 50% over existing water-based processes, saving an estimated 2 million gallons/yr per machine at full load capacity.
  - The process is much gentler on fabric, resulting in increased clothing life due to less pilling, reduced shrinkage, and less wear.
- **Next Steps:** Continue optimizing the system throughput and performance. The drive system will undergo design changes for full commercialization to reduce maintenance and improve system performance.



# Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<b>2011 Emerging Technology Demonstration Grant (ETDG II)</b>	Competitive grant solicitation targeting industrial energy efficiency demonstrations	<ul style="list-style-type: none"><li>• \$19.8M (E+NG) allocated to 14 passing projects</li><li>• Project started; results expected in 12-18 months</li></ul>
<b>2013 NG Emerging Technology Demonstration Grant (ETDG III)</b>	Competitive grant solicitation targeting natural gas energy efficiency technology demonstrations for IAW sector	<ul style="list-style-type: none"><li>• Stage 1 results posted: 12/30/13</li><li>• Stage 2 proposals due: 1/30/14</li><li>• Up to \$8.34M</li><li>• Awards in mid 2014</li></ul>
<b>Ongoing Industrial/Food Processing Research</b>	Research projects include: <ul style="list-style-type: none"><li>• latent heat recovery</li><li>• boiler efficiency improvements</li></ul>	<ul style="list-style-type: none"><li>• Projects in 3<sup>rd</sup> year of research</li><li>• M&amp;V starting/in progress</li></ul>
<b>Research for Industrial Use</b>	Sector-specific research (e.g., cement, food processing, pharmaceutical, chemical, glass) and road maps	<ul style="list-style-type: none"><li>• Staff continually reevaluates areas for IAW research portfolio</li><li>• Natural gas-IAW roadmap update underway by KEMA ; purpose is to identify future research priorities</li><li>• Roadmap will include public process for comments</li></ul>

# Proposed Funding Initiatives for FY 14/15

## Industrial, Agricultural and Water (IAW) Initiatives:

- **Natural Gas Efficiency Research and Demonstration for IAW:** RD&D to advance energy efficiency emerging/underutilized technologies to help energy intensive industries reduce energy and water demand and air and water emissions cost effectively. Potential industries include: food processing, glass, chemical manufacturing, cement, metals processing, and general manufacturing.
- **Heat Recovery:** RD&D on advanced technologies to recover waste heat from combustion systems and natural gas burners (industrial processes in general). Potential industries include: Oil and gas, food processing, glass, cement and metals manufacturing, and petroleum refineries.
- **Gas and Energy Reduction Through Capture and Sequestration:** Research to advance technologies to help large greenhouse gas emitting industries (cement, gas pipelines) to reduce or sequester emissions and energy use. Areas of research could include feasibility of using old gas pipelines to inject CO<sub>2</sub> underground or reformulations of cement to use less natural gas in manufacturing while emitting less CO<sub>2</sub> in the production process.

# Proposed Funding Initiatives for FY 14/15

- **Potential partners:**

- Industry
- Utilities
- Major equipment manufacturers
- Public/private research organizations
- Governmental agencies

- **Outreach:**

- Public workshops
- Meetings with industry and trade associations
- Discussions with utilities, governmental agencies and other stakeholders

- **Estimated ratepayer benefits:**

- Energy, water, and cost savings
- Environmental benefits (e.g., improved air quality, reduction in greenhouse gas emissions)- in general, more efficiency equals less emissions

# Proposed FY 2014/15 Budget

Initiatives	Proposed FY 2014/15 Natural Gas Budget
<b>Industrial, Agriculture and Water Efficiency</b> <ul style="list-style-type: none"><li data-bbox="161 721 1224 764">▪ Natural Gas Efficiency Research and Demonstration</li><li data-bbox="161 771 495 815">▪ Heat Recovery</li><li data-bbox="161 822 1148 937">▪ Gas and Energy Reduction Through Capture and Sequestration</li></ul>	\$4,300,000

# Questions for the Stakeholders on Industrial, Agricultural and Water Efficiency

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

# Natural Gas Research Areas/Initiatives

## Renewable Energy and Advanced Generation

- Combined Heat and Power (CHP)

# Renewable Energy and Advanced Generation



**Presenter:**  
**Rizaldo Aldas**

# Goals

The Program area goal is to reduce barriers and increase penetration of renewable energy.

**Under the Natural Gas research program**, our goal is to reduce dependence on fossil-derived natural gas by:

- Advancing the development and market availability of clean and efficient distributed generation (DG) and combined heat and power (CHP) technologies
- Developing hybrid generation, fuel-flexible, energy efficient and low emission natural gas DG technologies for alternative fuels including biogas and natural gas
- Developing and demonstrating diversified applications of advanced generation technologies that use renewable natural gas

# Policy Drivers

## AB 32, the California Global Warming Solutions Act of 2006

- Reduce GHG emissions to 1990 levels (~25% reduction from BAU) (2020)
- All emissions from new baseload generation must be at or below emissions from a natural gas combined cycle plant (2020)

## Governor Brown's Clean Energy Jobs Plan

- 6,500 MW Additional CHP Capacity (2030)

## Senate Bill X1-2 (Simitian, 2011), Renewable Portfolio Standard

- 20 percent of retail sales from renewables by the end of 2013, 25 percent by the end of 2016, and the 33 percent requirement being met by the end of 2020

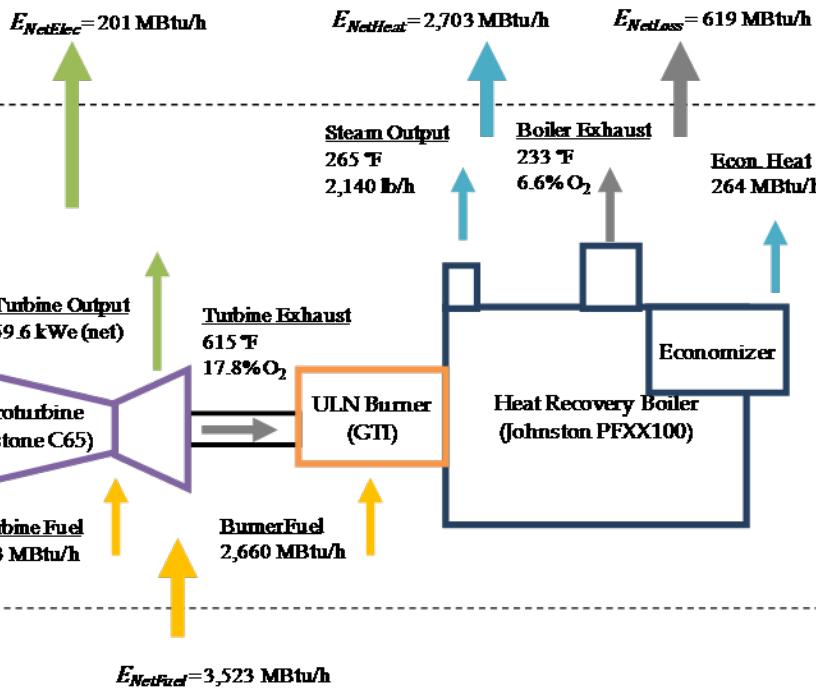
## AB 1613 (Blakeslee, Statutes of 2007), the Waste Heat and Carbon Emissions Reduction Act

- Require an electrical corporation to purchase excess electricity delivered by a CHP system that complies with certain sizing, energy efficiency and air pollution control requirements.

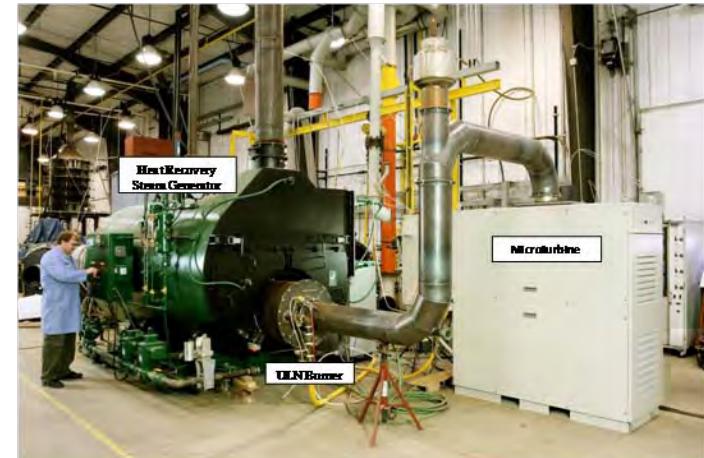
# Major Accomplishments

## Developed Integrated CHP that Reduces Costs While Meeting Emission Standards

- **Goal:** Develop a cost-effective gas turbine based CHP system that improves overall efficiency and meets CARB 2007 emission standards without catalytic exhaust gas treatment.



System Performance at Full Load – Host Site



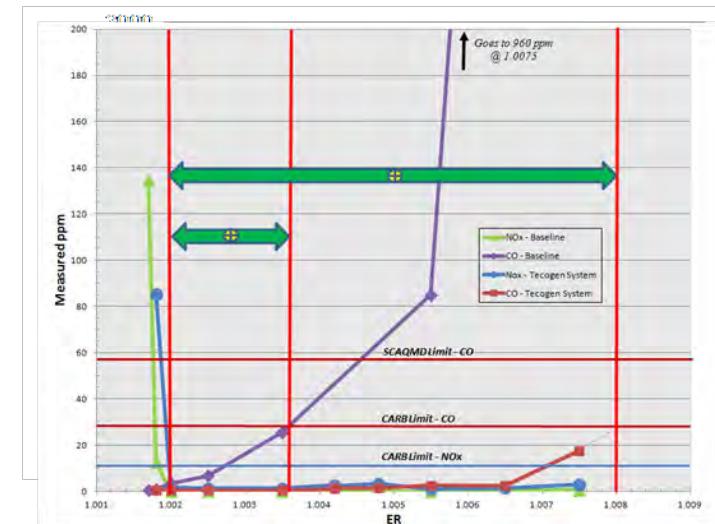
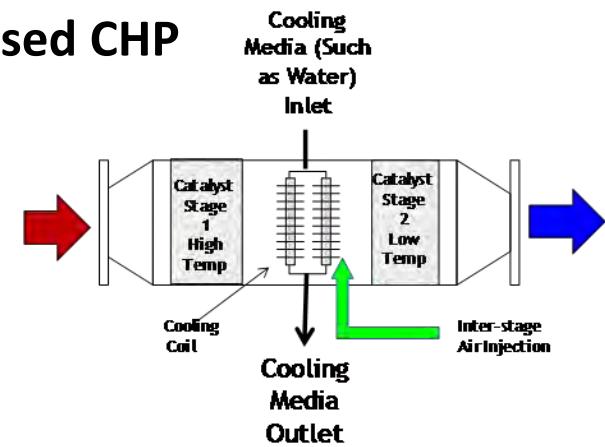
FlexCHP 65 System in Laboratory Testing at GTI

- **FlexCHP system has achieved performance objectives**
  - Achieved CARB 2007 emission standards
  - Achieved 84% (HHV) system efficiency
  - Generated a pre-engineered cost-effective CHP package employing state-of-the-art design concepts
  - Validated the system in the GTI laboratory
  - Demonstrated the system at a California host site
- **Contractor:** Gas Technology Institute
- **Funding:** \$501,437 (PIER); \$673,283 (Match)

# Major Accomplishments

## Developed Emission Control Technology for Engine-Based CHP

- **Goal:** Develop and test ultra-clean emission technology for small to medium engine CHP systems
- **Results:**
  - Decouples NOx and CO treatment
    - 1<sup>st</sup> stage operates rich and reduces NOx to negligible levels
    - 2<sup>nd</sup> stage operates lean to oxidize CO and VOCs to near zero levels
    - Proper conditioning of exhaust prior to 2<sup>nd</sup> stage is critical
  - Field Test Program Successful
  - CARB Compliant emissions (NOx and CO near zero)
  - AFR control window widened by nearly four times (375%)
- Now commercialized in Tecogen's InVerde *Ultra 100* and other CHP products, chillers & heat pump
- Adaptable to other natural gas engines



Third Party Test Results

- **Contractor:** DE Solutions, Inc.
- **Funding:** \$749,013 (PIER); \$371,586 (Match)

# Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
<b>Renewable Combined Heat and Power (CHP) and Distributed Energy Technologies</b>	Utilize alternative fuels with low carbon intensity such as biogas, flared gas and natural gas: <ul style="list-style-type: none"><li>• Biogas-Powered Microturbine</li><li>• CHP on biogas from dairy waste digester</li></ul>	Field testing; system performance data; Testing emissions control systems to determine BACT for biogas CHP
<b>Hybrid Generation and Fuel Flexible DG/CHP/CCHP</b>	Integrate emerging multiple DG/CHP/CCHP technologies and fuel flexibility. Implementing four projects: <ul style="list-style-type: none"><li>• Novel Flex Fuel Oxidation for Distributed Generation</li><li>• Combined Heat and Power with Thermal Storage for Modern Greenhouses</li><li>• Fuel-Flexible, Hybrid CHP at San Bernardino Municipal Water Department</li><li>• Tri-generation Energy System Technology</li></ul>	Projects started in Summer 2012; Completing preliminary technical tasks including baseline information, designs, laboratory tests, and other demonstration preparations

# Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
<b>Localized Efficient and Advanced Power and Heat Systems (LEAPS)</b>	<ul style="list-style-type: none"><li>Advanced CHP in opportunity areas in specific industrial and commercial facilities, biofuels sources, and waste heat and gas sources including associated gas from oil and gas production field locations</li><li>Reliable power through accelerated demonstration and deployment of DG/CHP in southern California</li></ul>	Program Opportunity Notice released on October 11, 2013 with applications deadline of December 20, 2013. Anticipated project start date is July 2014
<b>Natural Gas and Biogas in DG/CHP Integration, Impact Analysis and Demonstration</b>	Research that will advance biogas and Renewable Natural Gas (RNG) for DG/CHP Applications, bottoming cycle solutions to conserve natural gas, and investigate dynamics of natural gas integration at regional scales	Anticipated release of solicitation is early Spring 2014

# Proposed Funding Initiatives for FY 14/15

## Biomethane Enabling Technology Development for Remote Power Generation

- Supports the 2013 IEPR recommendation (and stakeholder input) on RD&D for biogas-to-biomethane technologies, including efforts related to pipeline injection
  - Provide the technological development needed to bring the costs down and advance the commercialization of biomethane technologies
  - Demonstrate and generate performance data for emerging biomethane technologies
  - Support breakthrough technologies and strategies that improve efficiency, cost-effectiveness, and availability at the biogas production and post-production level
- **Potential Partners and Customers:** Local, state and federal agencies, facility owners and operators, technology manufacturers and providers, universities, utilities
- **Ratepayer Benefits:**
- Increased energy security by increasing domestic production of non-fossil fuels, improved fuel accessibility, and reduced cost of production and transport
  - Reduced use of natural gas leading to financial savings in the long term, conservation of limited resource, and mitigation of greenhouse gas emissions
  - Increased economic opportunity by converting waste into revenue source while providing benefits to land, water and air environment

# Proposed Funding Initiatives for FY 14/15

## Clean Micro-Scale Systems for Power, Cooling, and Heating Applications

- Supports stakeholder input and advances emerging small-scale combined cooling, heating and power systems to provide benefits to California ratepayers
  - Addresses technical barriers to enhance market deployment of micro-CHP systems of up to 50 kWe size range
  - Reduce or augment NG use in light industrial, small commercial and possibly multiple residential settings
  - Emphasize high overall efficiency on NG, RNG, biogas, syngas or other renewable fuels
- **Potential Partners and Customers:** Facility owners and operators, technology manufacturers and providers, universities, utilities, and local, state and federal agencies
- **Ratepayer Benefits:**
- Reduce heating and electric bills through self-generation by providing an option better tailored to higher electric to thermal load applications
  - Improve air quality by reducing criteria pollutant emissions with beneficial impacts on health
  - Increase energy security, conserve limited fossil fuel resource, and help mitigate GHG emissions

# Proposed Funding Initiatives for FY 14/15

## Novel Systems for Small to Intermediate Combined Heat and Power

- Develop breakthrough clean and efficient CHP systems employing novel conversion methods and emissions control strategies
  - Supports synergistic integration of emerging and preferred generation systems (e.g. renewable fueled gas turbine with compressed air tanks or fuel cell and gas turbine)
  - Develop CHP systems that take advantage of opportunity gases, such as stranded gas, and other renewable sources
- **Potential Partners and Customers:** Facility owners and operators, technology manufacturers and providers, universities, utilities, and local, state and federal agencies
- **Ratepayer Benefits:**
- Provide highly efficient systems resulting to reduced consumption of natural gas, accrue savings in the long term and reduce GHG emissions
  - Effective and efficient NG power generation systems providing firming support for high penetration renewable energy
  - Increase energy security, opportunity to reduce customer-side heating and electricity expenses while improving air quality

# Proposed Funding Initiatives for FY 14/15

## Improving Cost-Effectiveness of Natural Gas Power Generation with Advanced Carbon Dioxide (CO<sub>2</sub>) Capture Technologies

**Purpose:** Follow on to DOE research on new and emerging carbon capture technologies from natural gas power plants to store or transfer for use. R&D on CO<sub>2</sub> capture technology will address three major issues:

- Reducing the impact of CO<sub>2</sub> capture on power generating capacity;
  - Scaling up novel CO<sub>2</sub> capture technologies to the necessary size for full-scale deployment
  - Improving the cost effectiveness of novel technologies for CO<sub>2</sub> capture
- **Potential Partners and Customers:** Federal agencies, power plant owners and operators, technology providers, universities, utilities, and local and state agencies
- **Ratepayer Benefits:**
- Improved cost-effectiveness of power plants while reducing amount of CO<sub>2</sub> emissions released into the atmosphere
  - Improved air and environmental quality and reduced climate change impacts

# Proposed FY 2014/15 Budget

Initiatives	Proposed FY 2014/15 Natural Gas Budget
<p><b>Renewable Energy and Advanced Generation</b></p> <ul style="list-style-type: none"><li>▪ Biomethane Enabling Technology Development for Remote Power Generation</li><li>▪ Clean Micro-Scale Systems for Power, Cooling, and Heating Applications</li><li>▪ Novel Systems for Small to Intermediate Combined Heat and Power</li><li>▪ Improving Cost-Effectiveness of Natural Gas Power Generation with Advanced Carbon Dioxide (CO<sub>2</sub>) Capture Technologies</li></ul>	\$3,500,000

# Questions for the Stakeholders on Renewable Energy and Advanced Generation Research Initiatives

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

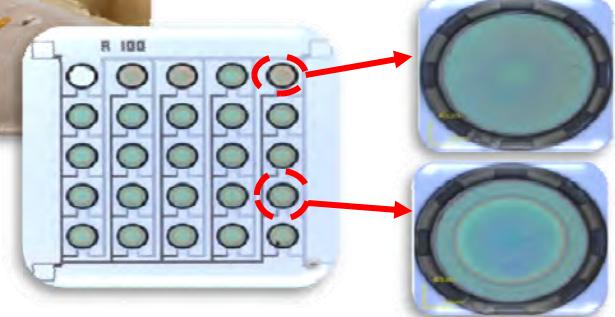
# Natural Gas Research Area/Initiatives

## Energy Infrastructure

- Natural Gas Pipeline Integrity
- Energy-Related Environmental Research
- Natural Gas-Related Transportation

# Natural Gas Pipeline Integrity

Presenter: Johann Karkheck



# Goals

- Conduct research in natural gas infrastructure not covered by the regulatory and competitive markets
- Research that results in tangible benefits to utility customers
  - Focus is on projects that have the potential to increase safety and enhance transmission and distribution capabilities of the natural gas system

# Policy Drivers

## Research to meet our Energy Policy Goals

### Public Resources Code 25620

- Provide environmentally sound, safe, reliable and affordable energy services and products
- Bring to market technologies that provide greater system reliability, increased environmental benefits and lower system costs

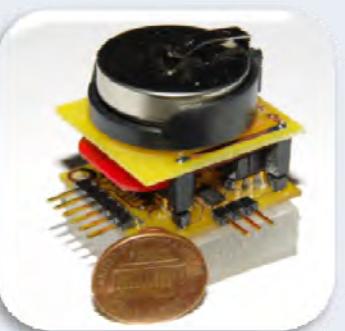


### 2011 Integrated Energy Policy Report

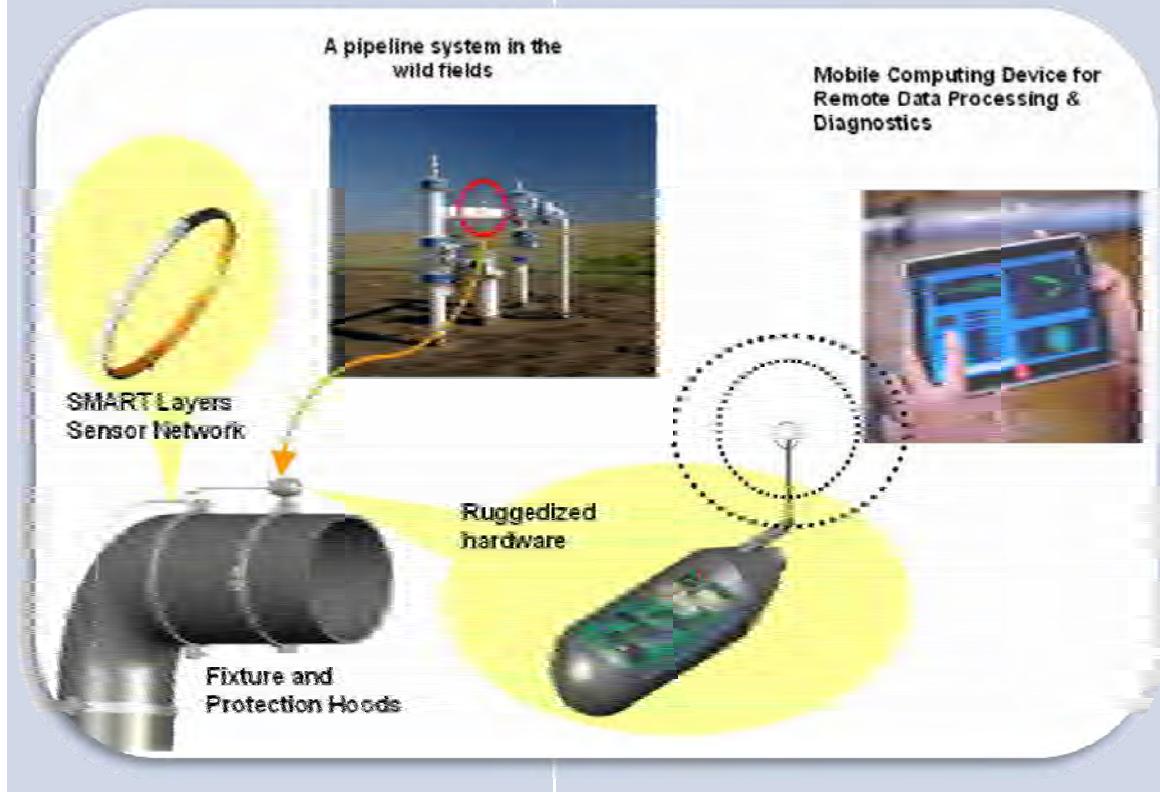
- *"The state needs public interest energy research to explore opportunities and apply new and emerging technologies that provide innovative options for natural gas pipeline integrity, operations, and safety."*

### Greenhouse Gas Emission Reduction – AB 32

# Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
<b>Best Practices in Monitoring Technology</b>	<ul style="list-style-type: none"><li>Developed a baseline assessment of technologies currently used nationwide and in California to manage pipeline integrity and safety</li><li>Identified emerging technologies</li><li>Developed implementation plan to bring emerging technologies to California</li></ul>	The final report is in the publications process including a catalog of available technologies, and implementation plan for development and demonstration of emerging technologies in the California pipeline network
<b>Innovative Monitoring Technologies</b>	<ul style="list-style-type: none"><li>Found and developed new technologies to inspect, monitor and report on the operating condition of natural gas pipelines</li></ul> 	<p>Finalizing MEMS sensor package designs</p> <p>Next Steps:</p> <ol style="list-style-type: none"><li>1. Fabrication of pipeline sensor test bed</li><li>2. Reliability testing and refinement of sensor designs</li><li>3. Development of low cost installation method</li></ol>

# Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
<b>Real-Time Active Pipeline Integrity Detection (RAPID)</b>	Continuous pipeline monitoring using piezoelectric transducers/sensors	<p>Coordinating with PG&amp;E to deploy a monitoring system on an above ground regulator station for corrosion monitoring</p> <p>Next Steps:</p> <ol style="list-style-type: none"><li>1. Design and development of monitoring system using specifications from PG&amp;E</li><li>2. Utility scale demonstration</li></ol> 

# Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
<b>In-Line-Inspection Technologies: Accurately Locating and Measuring Pipeline Girth Welds</b>	Development and demonstration of a multichannel electromagnetic acoustic transducer for existing pipeline inspection crawlers to provide more accurate evaluation of girth welds	<p>Design and manufacturing of hardware components is completed. Control and signal conversion software are under development</p> <p>Next Steps:</p> <ol style="list-style-type: none"><li>1. Complete hardware and software integration</li><li>2. Demonstration of sensor on company test pipelines</li><li>3. Demonstration of sensor on PG&amp;E pipeline</li></ol> 

# Proposed Funding Initiatives for FY 14/15

## Natural Gas Pipeline Safety and Integrity:

- **Description:** Continue system development and utility scale demonstrations of emerging pipeline safety and integrity technologies. Assist in market facilitation of technologies to increase tools available to California pipeline operators.
- **Potential partners/customers:** Natural Gas Utilities, Pipeline Industry, Research Institutions, Policymakers & Regulators
- **Advances science and technology:** Increased accuracy of pipeline inspection technologies, provide operators more precise data on current status of pipeline network
- **Rate payer benefits:** Improve the safety and security of natural gas pipelines, improve reliability of natural gas pipeline network

# Proposed FY 2014/15 Budget

Initiatives	Proposed FY 2014/15 Natural Gas Budget
<b>Natural Gas Pipeline Integrity</b> <ul style="list-style-type: none"><li>▪ Natural Gas Pipeline Safety and Integrity</li></ul>	\$2,500,000

# Questions for the Stakeholders on Natural Gas Pipeline Integrity

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?



# Energy-Related Environmental Research



**Presenter:**  
**Guido Franco**

# Goals

- Develop cost-effective approaches to evaluating and resolving environmental effects of energy production, delivery and use in California; explore how new energy applications and products can solve/mitigate environmental problems; identify vulnerabilities of the energy system to climate change and develop cost-effective approaches to ensure reliable energy services.
- Complement research efforts by producing California-specific products that also inform policy formulation, in these areas:
  - Energy – related climate change
  - Energy – related air quality
  - Energy - related terrestrial resources
  - Energy – related aquatic resources

# Policy Drivers

**Warren-Alquist Act:** CEQA equivalent environmental evaluations for power plants

**IEPR:** Energy-related Environmental Research Priorities

**Safeguarding California:** An update to the Adaptation Strategy that was adopted by the Governor in 2009. It identify adaptation measures that state agencies should implement.

**SB1250:** Increased energy efficiency, reduce or eliminate consumption of water and other finite resources, increase renewable energy

**Loading Order:** Increase energy efficiency, renewable energy, clean fossil generation, infrastructure improvements

**Title 24:** Promote energy efficiency through building standards

**AB 32:** Reduce GHG to 1990 levels by 2020

**Governor Brown's State Energy Plan:** 12,000 MW localized Generation, 8,000 MW Large Scale Renewable, 6,500 MW CHP

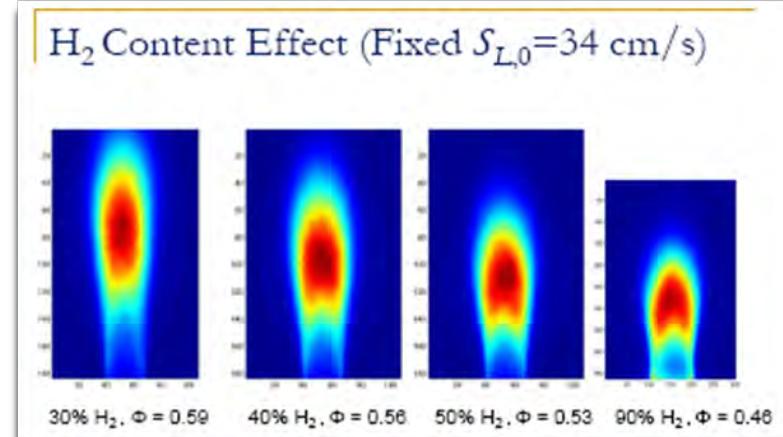
**SB X 1-2:** RPS, 33% by 2020

**AB 1925/SB 1368:** accelerate CCS for industrial CO2

# Major Accomplishments

## Gas Fuel Interchangeability Criteria

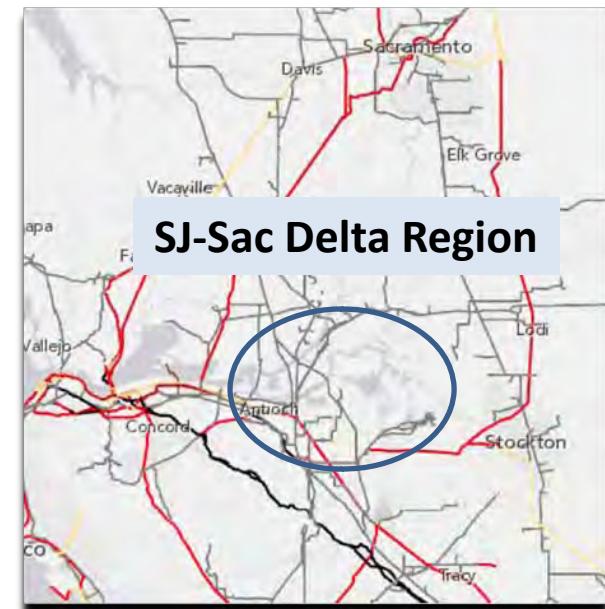
- Develop simulation methodology to estimate the impact of varying fuel composition on stability and pollutant emissions of combustion systems.
- **Contractor:** University of California at Irvine
- **PIER funding amount:** \$1,133,714
- **Results:** Demonstrated simulation methodology able to correctly predict trends in emissions and combustion stability as function of fuel composition for limited number of burner configurations.
- **Rate payer benefits:** Inform regulatory decision makers on air emissions and burner safety of using new gaseous fuel compositions (e.g., biogas) - quicker and cheaper than testing.



# Major Accomplishments

## Potential Effects of Sea-Level Rise on Energy Infrastructure in the Sacramento-San Joaquin Delta

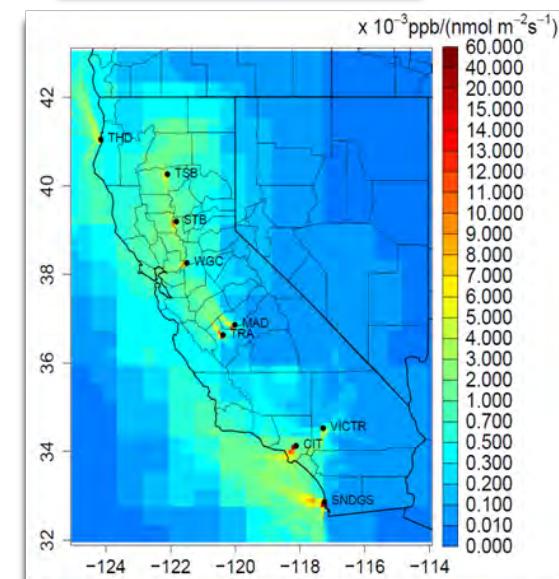
- Using advanced hydrological models of sea level rise and inundation coupled with gas pipeline infrastructure maps to model vulnerabilities to climate change.
- **Contractor:** University of California, Berkeley
- **PIER funding:** \$425,000
- **Results:** Projected sea-level rise coupled with a 100-year extreme storm event could threaten a substantial portion of natural gas pipelines and related energy infrastructure.
- **Rate payer benefits:** Preparing for sea level rise and extreme storm events is essential to ensuring reliable provision of natural gas to ratepayers. First we must identify vulnerable infrastructure.



# Major Accomplishments

## Atmospheric GHG Measurements

- Using ambient measurements of GHG to “verify” the ARB inventory and estimate major sources of fugitive methane emissions from the natural gas system.
- **Contractor:** LBNL, UC Davis, collaboration with ARB
- **PIER funding:** \$900,000
- **Results:** Methane emissions in California may be underestimated by 50%. On-going field studies in California are investigating fugitive emissions from different components of the natural gas system.
- **Rate payer benefits:** Natural Gas Utilities will be part of the cap-and-trade program. Improved emission estimates are essential for the environmental integrity of AB32 and post 2020 GHG targets.



# Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
<b>Investigations of Potential Induced Seismicity Related to Geologic Carbon Dioxide Sequestration in California</b>	<ol style="list-style-type: none"><li>1) Analyze information depicting the occurrence of oil and gas production-related induced seismicity;</li><li>2) Conduct laboratory measurements of the fracture permeability of natural cap rock samples.</li></ol>	<ol style="list-style-type: none"><li>1) Project recently kicked off;</li><li>2) First task: compile and analyze information on the occurrence of oil and gas production-related seismicity.</li></ol>
<b>Evaluation and Improvement of Particulate Matter Measurement from NG Power Plants</b>	<ol style="list-style-type: none"><li>1) Evaluate current methods for measuring PM emissions from power plants;</li><li>2) Conduct pilot-scale study of PM measurements;</li><li>3) Demonstrate improved PM measurement method;</li><li>4) Develop new PM test methods.</li></ol>	<ol style="list-style-type: none"><li>1) Project on-going;</li><li>2) Conducted pilot-scale study;</li><li>3) Analyzing results and determining best path forward.</li></ol>
<b>Investigating Options that Could Reduce Net GHG Emissions from the NG System and/or Provide Offsets</b>	<ol style="list-style-type: none"><li>1) Survey of methane emissions from key subsectors of the NG system;</li><li>2) Options to reduce methane emissions from NG facilities.</li></ol>	<ol style="list-style-type: none"><li>1) Survey recently kicked off;</li><li>2) Investigation of options on-going.</li></ol>

# Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
<b>NOx Control Research and Development</b>	1) Develop combustion or post-combustion control technologies for residential or commercial natural gas-fired devices with potential to significantly reduce NOx emissions.	1) Soliciting proposals.
<b>Low-Cost High Sensitivity NOx Sensors</b>	1) Design a NOx sensor for high priority DG technology; 2) Build and test prototype sensors and evaluate response in simulated DG environment in laboratory; 3) Test NOx sensor on an operating DG.	1) Project on-going; 2) Evaluated 2 <sup>nd</sup> generation prototype in lab and field tested at Orange County Sanitation District (OCSD); 3) Analyzing results and will modify and retest sensor at OCSD.
<b>Vulnerability of the Natural Gas System to Climate Change: initial studies</b>	1) Estimating impacts in the Delta Region; 2) Estimating subsidence of levees; 3) Improved sea-level rise projections.	1) Project on-going; 2) Designing these projects.

# Proposed Funding Initiatives for FY 14/15

## Quantification of Fugitive Methane Emissions from Commercial Buildings in California

- **Description:** Although previous research has established that fugitive methane emissions exceed those accounted for in the state's inventory, the sources of these emissions remain to be identified and quantified. Initial measurements have indicated that post-metering losses in homes may be a significant source of emissions. This work will examine the extent of similar losses in commercial buildings.
- **Potential Partners/Customers:** Natural Gas Utilities, ARB, end users, policymakers and regulators.
- **Advances in Science and Technology:** Little is known about the extent of natural gas emissions from commercial buildings.
- **Rate Payer Benefits:** Post-metering emissions are losses of natural gas that the rate payer has already purchased. Reductions in these losses will result in lower natural gas bills but, more importantly, lower GHG emissions.

# Proposed Funding Initiatives for FY 14/15

## Probabilistic Seasonal and Decadal Forecasting to Support Robust, Cost-Effective Management of Fluctuations in Natural Gas Supply and Demand

- **Description:** Probabilistic forecast to be tailored to the needs of natural gas demand forecasters in the Energy Commission. Natural gas supply and demand are subject to climate-related fluctuations that affect storage capacity as well as consumption. Improved forecasts of factors affecting supply and demand on seasonal and decadal timescales may improve management and planning.
- **Potential Partners/Customers:** Natural Gas Utilities, Policymakers & Regulators
- **Advances in Science and Technology:** Investigation of forecasting skills using sea-surface temperatures and other variables for forecasts tailored to the natural gas planners.
- **Rate Payer Benefits:** Improved forecasts will allow for better planning in order avoid potential climate-related gas shortages and price spikes.

# Proposed Funding Initiatives for FY 14/15

## Climate Readiness Options for the Natural Gas Sector: Regional Studies

- **Description:** Building on ongoing work, this effort will support two or three studies to clarify regionally specific vulnerabilities of the natural gas system as well as investment strategies to support timely, cost-effective adaptation. Examples of possible research include refined projections of sea level rise impacts to open coastal areas; infrastructure vulnerabilities to inland flooding; planning for sea level rise and wave run-up under uncertainty; identification of institutional, regulatory, and financial barriers to adaptation and means to address them; identification of ratepayers most vulnerable to disruptions in supply as well as options to foster resilience.
- **Potential Partners/Customers:** Natural Gas Utilities, CPUC, ARB, CAISO, CalEMA, Natural Resources Agency, OEHHA, CDPH
- **Advances in Science and Technology:** Research will improve understanding of climate change impacts on the natural gas sector and support planning to protect infrastructure and vulnerable populations.
- **Rate Payer Benefits:** Without preparation for expected climate impacts the natural gas system will be vulnerable to major disruptions.

# Proposed Funding Initiatives for FY 14/15

## Visualizing Climate-Related Risks to the Natural Gas System Using Cal-Adapt

- **Description:** Recognizing that the natural gas system is vulnerable to climate-related changes and events such as sea level rise and wave run-up, inland flooding, and subsidence of the delta and levees, this work will ensure that the best peer-reviewed scientific results are visualized in a readily accessible, understandable form to support planning and adaptation efforts. This effort will leverage the State's Cal-Adapt platform.
- **Potential Partners/Customers:** Natural Gas Utilities, CPUC, CAISO, CalEMA, Natural Resources Agency
- **Advances in Science and Technology:** Projects will provide critical support to communicate scientific advances regarding climate-related risks to the natural gas sector and foster planning to protect infrastructure and vulnerable populations.
- **Rate Payer Benefits:** Delivery of readily understandable visualizations depicting climate-related risks to stakeholders who are responsible for protecting natural gas infrastructure and planning for future reliability will support efforts to protect ratepayers from major disruptions, support smoothly functioning markets, and safeguard against environmental impacts from infrastructure failures.

# Proposed Funding Initiatives for FY 14/15

## Assessment of Current and Potential Environmental Value of Residential Solar Water Heating in California

- **Description:** This research will evaluate potential environmental cost/benefits and economics associated with solar thermal water heating using actual performance data from California homes. A scoping study will probe performance of current installations; identify factors that affect environmental benefits; delineate potential environmental benefits of residential SWH; and illuminate specific niches, characterized by, e.g., physical factors, socioeconomic characteristics, or usage patterns, where SWH could garner substantial, cost-effect environmental benefits.
- **Potential Partners/Customers:** Natural Gas Utilities, CPUC
- **Advances in Science and Technology:** Improve understanding of SWH technologies' current and potential performance.
- **Rate Payer Benefits:** Clarification of current and potential benefits of SWH; and identification of niches where SWH could provide the most cost-effective benefits.

# Proposed FY 2014/15 Budget

Initiative	Proposed FY 2014/15 Natural Gas Budget
<p><b>Energy-Related Environmental Research</b></p> <ul style="list-style-type: none"><li>▪ Quantification of Fugitive Methane Emissions from Commercial Buildings in California</li><li>▪ Probabilistic Seasonal and Decadal Forecasting to Support Robust, Cost-Effective Management of Fluctuations in Natural Gas Supply and Demand</li><li>▪ Climate Readiness Options for the Natural Gas Sector: Regional Studies</li><li>▪ Visualizing Climate-Related Risks to the Natural Gas System Using Cal-Adapt</li><li>▪ Assessment of Current and Potential Environmental Value of Residential Solar Water Heating in California</li></ul>	\$3,000,000

# Questions for the Stakeholders on Energy-Related Environmental Research

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

# Natural Gas-Related Transportation



**Presenter:**  
**Reynaldo Gonzalez**

# Goals

- **The goals of transportation-related research are to:**
  - Accelerate the commercial availability of natural gas vehicles.
  - Improve energy efficiency of natural gas vehicles.
  - Advance the clean and cost-effective production of renewable natural gas for transportation use.
  
- **As a transportation fuel, natural gas has potential to:**
  - Offset more than 885 million gallons of gasoline and diesel per year by 2022.
  - Reduce annual GHG emissions by 4.4 million metric tons by 2022.
  - Save the state approximately \$1.35 billion annually in fueling costs.

# Policy Drivers

The following legislation and policy guide the Natural Gas-Related Transportation research area on meeting California's challenges:

**State Alternative Fuels Plan:** Presents strategies and actions California must take to increase the use of alternative transportation fuels including natural gas.

**2013 Integrated Energy Policy Report:** Growth scenario shows sixfold increase in natural gas vehicles between 2012 and 2020.

**Senate Bill 1250:** Enables PIER funds to be used for advanced transportation technologies that:

- Reduce air pollution and GHG emissions beyond applicable standards.
- Benefit natural gas ratepayers.

**Assembly Bill 32:** Calls for approximately 36% of the state's 2020 GHG reduction targets to come from the transportation sector.

# Major Accomplishments

## Natural Gas Engine and Vehicle Integration Research

- **Purpose:** Development, integration, and demonstration of the 11.9 liter, heavy-duty stoichiometric spark-ignited natural gas engine with performance and emission attributes suitable for Class 8 regional haul and vocational truck applications.
- **Contractor:** NREL
- **Partners:** Cummins Westport, Inc.
- **R&D Funds:** \$4.25M with \$13.1M in match funds
- **Results:** Successfully met the project objectives: criteria emission pollutants lower than CARB 2010, 400 HP & 1350 ft lbs torque, and about 25% reduction in GHG emissions over current Class 8 engines. **The Cummins Westport ISX12 G natural gas engine entered the commercial market in late 2013.**
- **Rate Payer Benefits:** Approximately 97,500,000 gallons of diesel and 13 MMT of CO<sub>2</sub>e can be displaced per year based on 10% market penetration.



# Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
<b>Develop and Demonstrate an Ultra Low Emissions, High Performance Spark Ignited Natural Gas Engine</b>	GTI is partnering with Cummins Westport, Inc. (CWI) to develop and validate an Alpha engine design for a new, high-performance, spark-ignited, dedicated natural gas 6.7 liter engine.	In progress. Alpha version of engine expected to be completed in 2015. <i>Potential for AB118 to fund Demonstration</i>
<b>Near-Zero Emission Technology Research for Heavy-Duty Natural Gas Vehicles</b>	Reduce NOx levels by 90% through advanced engine technologies. Objective is to obtain near-zero NOx levels while continuing to meet or exceed other emission standards without incurring a fuel economy penalty.	In progress. Expected project completion in 2016. <i>AB118 funding Demonstration</i>
<b>Natural Gas Vehicle On-Board Storage</b>	Develop and demonstrate advanced natural gas tank technologies providing a safe, low-pressure, high-density, conformable storage system that enables cost-effective home refilling of NG vehicles.	Work authorization to determine research gaps; existing research is being conducted to improve storage.

# Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
<b>Natural Gas Vehicle Hybridization</b>	Develop and demonstrate hybridization designs that use battery power to minimize emissions, idle, and low-load engine operation.	Solicitation to be released early 2014.
<b>Natural Gas Fueling Infrastructure Improvements</b>	Develop technologies and processes to reduce natural gas venting and fugitive emissions, improve equipment efficiency, and improve economics.	Solicitation to be released mid-2014.
<b>Advanced Ignition Engine Research</b>	Develop advanced ignition methods to improve efficiency while reducing emissions.	Solicitation to be released mid-2014

# Proposed Funding Initiatives for FY 14/15

## Mid-Size Engine Integration and Demonstration

- **Description:** This research will build on current efforts that focus on the development of natural gas engines suitable for a variety of class 3 through 7 vehicles. OEMs need to integrate the engines into suitable vehicle applications and demonstrate them in representative fleet operations in order to accelerate penetration into markets that have not yet realized the full benefits of natural gas usage because of limited engine options.
- **Potential partners:** Private institutions, research entities, other governmental agencies.
- **How it advances science and technology and not duplicative of previous research:** This research primarily targets medium and heavy-duty natural gas vehicle applications; however technology advancements from this research can be applied to hybridized solutions, stationary engines for distributed generation, and combined heat and power systems.
- **Estimated Ratepayer Benefits:** This research will lead to improved efficiency, reduced emissions, and improved air quality.

# Proposed Funding Initiatives for FY 14/15

## On-Road and Advanced Emission Testing for Fleets

- **Description:** This research will fully characterize the emissions profile of current and near term natural gas engines across multiple applications and various duty-cycles in “real world” on-road conditions. Current engine certifications provide a limited catalog of the emission reduction potential including GHG benefits for NGVs. On-road testing is the most accurate method for determining the true emissions profile, evaluating the deterioration of performance, and measuring fuel economy.
- **Potential partners:** Federal agencies, research institutions, local air districts, California based fleets
- **How it advances science and technology:** Fully characterizing a natural gas engine’s emission, performance, and fuel usage profile will better inform regulators and fleets as natural gas engine technologies are developed and marketed for California fleets. The expanded testing will also enhance future designs of natural gas engine technologies.
- **Estimated Ratepayer Benefits:** Improved air quality through emission reduction benefits realized through advanced emission testing research.

# Proposed FY 2014/15 Budget

Initiatives	Proposed FY 2014/15 Natural Gas Budget
<p><b>Natural Gas-Related Transportation</b></p> <ul style="list-style-type: none"><li>▪ Mid-Size Engine Integration and Demonstration</li><li>▪ On-Road and Advanced Emission Testing for Fleets</li></ul>	\$4,000,000

# Questions for the Stakeholders on Natural Gas-Related Transportation

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

## **Public Comments (General Questions)**

# Closing Comments

- Submit additional written comments to: Johann Karkheck ([Johann.Karkheck@energy.ca.gov](mailto:Johann.Karkheck@energy.ca.gov)) by **5:00 pm on January 31, 2014**
- Staff will consider comments and prepare draft natural gas research budget
- Final draft to be submitted to the California Public Utilities Commission by March 28, 2014
- Copies of presentations, public comments and responses to questions from today's workshop will be posted under January 28, 2014 at:  
<http://www.energy.ca.gov/research/notices/index.html#01282014>
- Copies of past budget annual reports can be found at:  
[http://www.energy.ca.gov/research/annual\\_reports.html](http://www.energy.ca.gov/research/annual_reports.html)